

Geometry 13-4 Study Guide: Two-Way Tables (p 899-906)

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Attendance Problems. A bag contains 4 red and 2 yellow marbles. A marble is selected, kept out of the bag, and another marble is selected. Find each conditional probability of selecting the second marble.

1. $P(\text{red} \mid \text{red})$

2. $P(\text{red} \mid \text{yellow})$

3. $P(\text{yellow} \mid \text{yellow})$

4. $P(\text{yellow} \mid \text{red})$

5. A bag contains 4 red and 2 yellow marbles. A marble is selected, kept out of the bag, and another marble is selected. Find $P(\text{two red marbles})$.

I can construct and interpret two-way frequency tables of data when two categories are associated with each object being classified.

Vocabulary
joint relative frequency
marginal relative frequency
conditional relative frequency

Common Core

- **CC.9-12.S.CP.4** Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.
- **C.9-12.S.CP.6** Find the conditional probability of A given B ... and interpret the answer in terms of the model.

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A *two-way table* is a useful way to organize data that can be categorized by two variables. Suppose you asked 20 children and adults whether they liked broccoli. The table shows one way to arrange the data.

	Yes	No
Children	3	8
Adults	7	2

The **joint relative frequencies** are the values in each category divided by the total number of values, shown by the shaded cells in the table. Each value is divided by 20, the total number of individuals.

The **marginal relative frequencies** are found by adding the joint relative frequencies in each row and column.

	Yes	No	Total
Children	0.15	0.4	0.55
Adults	0.35	0.1	0.45
Total	0.5	0.5	1

To find a **conditional relative frequency**, divide the joint relative frequency by the marginal relative frequency. Conditional relative frequencies can be used to find conditional probabilities.

1 Finding Joint and Marginal Relative Frequencies

The table shows the results of a poll of 80 randomly selected high school students who were asked if they prefer math or English. Make a table of the joint and marginal relative frequencies.

	9th grade	10th grade	11th grade	12th grade
Math	10	12	11	8
English	12	11	8	8

Divide each value by the total of 80 to find the joint relative frequencies, and add each row and column to find the marginal relative frequencies.

	9th grade	10th grade	11th grade	12th grade	Total
Math	0.125	0.15	0.1375	0.1	0.5125
English	0.15	0.1375	0.1	0.1	0.4875
Total	0.275	0.2875	0.2375	0.2	1

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Example 1. The table shows the results of randomly selected car insurance quotes for 125 cars made by an insurance company in one week. Make a table of the joint and marginal relative frequencies.

	Teen	Adult
0 accidents	15	53
1 accident	4	32
2+ accidents	9	12

6. The table shows the number of books sold at a library sale. Make a table of the joint and marginal relative frequencies.

	Fiction	Nonfiction
Hardcover	28	52
Paperback	94	36

2 Using Conditional Relative Frequency to Find Probability

A sociologist collected data on the types of pets in 100 randomly selected households, and summarized the results in a table.

		Owns a cat	
		Yes	No
Owns a dog	Yes	15	24
	No	18	43

A Make a table of the joint and marginal relative frequencies.

		Owns a cat		
		Yes	No	Total
Owns a dog	Yes	0.15	0.24	0.39
	No	0.18	0.43	0.61
	Total	0.33	0.67	1



B If you are given that a household has a dog, what is the probability that the household also has a cat? Use the conditional relative frequency for the row with the condition “Owns a dog.” The total for households with dogs is 0.39, or 39%. Out of these, 0.15, or 15%, also have cats. The conditional relative frequency is $\frac{0.15}{0.39} \approx 0.38$. Given that a household has a dog, there is a probability of about 0.38 that the household also has a cat.

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Example 2. A reporter asked 150 voters if they plan to vote in favor of a new library and a new arena. The table shows the results. Make a table of the joint and marginal relative frequencies. If you are given that a voter plans to vote *no* to the new library, what is the probability the voter also plans to say no to the new arena?

Arena	Library	
	Yes	No
	Yes	No
Yes	21	30
No	57	42

7. The classes at a dance academy include ballet and tap dancing. Enrollment in these classes is shown in the table. Complete the table of the joint relative frequencies and marginal relative frequencies. . If you are given that a student is taking ballet, what is the probability that the student is not taking tap?

Tap	Ballet	
	Yes	No
	Yes	No
Yes	38	52
No	86	24

Tap	Ballet		
	Yes	No	Total
	Yes	No	Total
Yes			
No			
Total			1

3 Comparing Conditional Probabilities

Tomas is trying to decide on the best possible route to drive to work. He has a choice of three possible routes. On each day, he randomly selects a route and keeps track of whether he is late. After a 40-day trial, his notes look like this.

	Late	Not Late
Route A		
Route B		
Route C		

Use conditional probabilities to determine the best route for Tomas to take to work.

Create a table of joint and marginal relative frequencies. There are 40 data values, so divide each frequency by 40.

	Late	Not late	Total
Route A	0.1	0.25	0.35
Route B	0.075	0.175	0.25
Route C	0.1	0.3	0.4
Total	0.275	0.725	1

To find the conditional probabilities, divide the joint relative frequency of being late by the marginal relative frequency in each row.

$$P(\text{being late if driving Route A}) = \frac{0.1}{0.35} \approx 0.29$$

$$P(\text{being late if driving Route B}) = \frac{0.075}{0.25} = 0.3$$

$$P(\text{being late if driving Route C}) = \frac{0.1}{0.4} = 0.25$$

The probability of being late is least for Route C. Based on the sample, Tomas is least likely to be late if he takes Route C.

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Example 3. A company sells items in a store, online, and through a catalog. A manager recorded whether or not the 50 sales made one day were paid for with a gift card. Use conditional probabilities to determine for which method a customer is most likely to pay with a gift card.

	Gift Card	Another Method
Store		
Online		
Catalog		

8. **Guided Practice.** Francine is evaluating three driving schools. She asked 50 people who attended the schools whether they passed their driving tests on the first try. Use conditional probabilities to determine which is the best school. Use conditional probabilities to determine which is the best school.

	Pass	Fail
Al's Driving		
Drive Time		
Crash Course		

13-4 Two Tables (p 903) 7-11, 14, 15, 17, 18, 19.